A new generation of Isocracking® catalysts

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The development of next generations of Isocracking® catalysts is the result of a lot of hard work by skilled scientists. Changes in crude supply and fuel specifications, limited capital, and economic incentives to hydropyrolysis of lower-valued refinery streams using existing plant equipment are some of the challenges that spurred invention of the new generation of hydrotreating catalysts. Catalyst innovations at Chevron Lummus Global (CLG) have answered these demanding challenges by providing cost-effective solutions. This paper describes two of CLG’s latest, fifth-generation catalysts: ICR 177 and ICR 178.

INTRODUCTION

Chevron has long been active in the research, development and commercialisation of hydrotreating technology. During the 1950s, research at Chevron’s Richmond Technology Center led to the development of Isocracking, the first modern hydrotreating process. The first Isocracking unit was started up in a licensee refinery in 1961, and Chevron’s first Isocracking unit started operation in the Pascagoula refinery (Mississippi, US) in 1963. Both of these units used first-generation catalysts.

Continued research at Chevron led to the development of an improved, second generation of Isocracking catalysts based on the proprietary cogel technology. These second-generation catalysts formed the basis for Isocracking units constructed in Chevron’s Richmond and El Segundo refineries (California, US) and a second Isocracking unit built in Pascagoula. Also, numerous licensee Isocracking units were built and started up during the 1960s and 1970s.

By the late 1970s, the third generation Isocracking catalysts were commercialised. These replaced second-generation catalysts in many Isocracking units, both in Chevron and licensee refineries. In the late 1980’s the fourth generation of Isocracking catalysts began replacing earlier versions.

Each successive generation of catalyst technology has shown improved performance. The first Pascagoula Isocracking unit, for example, achieved a catalyst first cycle of 1–2 years; with the fourth-generation formulation, the second-stage catalyst lasted 10 years while processing higher throughputs of more difficult feed.

We are now entering the era of the fifth generation of Isocracking catalyst technology, of which this paper describes two of our latest catalysts: ICR 177 and ICR 178.

NEW HYDROCRACKING PRETREAT CATALYST, ICR 178

CLG has recently commercialised a new VGO hydrotreating and hydrocracking pretreat catalyst, ICR 178. This new base metal/amorphous catalyst outperforms industry standard products in hydrotreatment, cracking and coking services.

ICR 178 owes its success to a number of formulation improvements. The hydrogenation function has been improved through the use of optimal solution pH during preparation. Figure 1 illustrates that the optimisation of solution pH can increase HDN activity by approximately 15%. New alumina chemistry has increased the relative HDN activity by approximately 20%, also shown in Fig. 1. These formulation improvements have increased HDN cycle length by a factor of 2 over the industry standard HCR pretreat catalyst. Fig. 2 depicts the relative performances in a laboratory pilot test.

ICR 178 is performing well in two Chevron hydrocrackers and in two licensee Isocracking units. This new HCR pretreat catalyst exhibits excellent hydrotreatment and hydrogenation activity and has loaded at 10% lower bulk density than previous-generation catalysts.

Currently, CLG is improving this type of catalyst further, in order to obtain even better HDN activity and provide the flexibility to process very difficult straight-run and previously cracked VGOs.

NEW SINGLE-STAGE HYDROCRACKING CATALYST, ICR 177

Along with pretreat catalyst ICR 178, CLG developed a next generation of single-stage, once-through (SSOT) hydrocracking catalysts. This new generation of catalysts represents a major technological breakthrough.
A new generation of Isocracking catalysts

Continued from page 8

The new catalysts are characterised by an optimised pore size distribution that significantly enhances the wax (paraffin) hydroprocessing capability. As a result, these catalysts are redefining the activity-performance relationship of Chevron’s Isocracking® catalyst portfolio.

The first of these new catalysts to be available is ICR 177. Relative to its state-of-the-art, base metal/zeolite predecessor catalyst ICR 142, ICR 177 is more active for conversion and provides a higher yield of base oils and other heavy distillates. Table 1 quantifies the advantage of ICR 177 over a current generation hydrocracking catalyst. ICR 177 enjoys a 21% conversion advantage while providing the same yield structure in the SSOT hydrocracking unit.

Table 2 shows that the two Isocracking catalysts generate equivalent yields for Middle Distillates. TABLE 1 presents the yield structure for four commercial units. Our latest single-stage, once-through catalyst, ICR 177 is ready for its commercial application.

As an analogy, imagine you sell cars from a large showroom, and over the years you’ve carefully developed a set of Excel worksheets in which you basically analyse and run the whole business. Now, say Microsoft came out with a version of Excel that wasn’t compatible with all of those Excel templates, for the company to get the best technology they’d have to throw away all the sweat and tears of the knowledge that’s in all their Excel templates,” he says. “In a refinery, that kind of knowledge includes what to do in an emergency, what to do in case of certain alarms. So a lot of effort has gone into giving people the latest technology without ripping out all the ‘Input/Output, all the termination facilities.”

So what about the prospect of newly built refineries in China and the substantial brownfield projects in the Middle East? Is the fact that these facilities are less fettered by backwards compatibility mean they can halve their workforce?

“We will, we are seeing a leapfrog effect in that the latest technologies are being brought into the newer refineries,” he says. “And in many cases, you can be more effective with less people. But if you take a control room that once had 12 people, you might see 10 people there today.

“In people terms, the main difference is how someone chooses to do the implementation and then support. But it’s in the technologies like maintenance predicting and asset management that some of the real gains lie.

“If you wait until a rotary pump fails, versus predicting when it might need some maintenance, then you can plan an orderly outage—or even repair it online. But if you wait until you have a catastrophic failure then you’ve got an entirely different problem—and the costs can be enormous.

“I don’t have the figures to hand, but the Abnormal Situation Management Consortium, in which Honeywell is one of many participants, has found that unexpected, unplanned-for outages represent a major cost in the refining industry.”

A new generation of Isocracking catalysts

Do business locally and don’t throw out technologies you trust

Many refining operations have spent a decade refocusing on their core competence and outsourcing the rest. That’s fine, so far as it goes, says Paul Orzeske, Honeywell Process Solutions VP and General Manager. But, he warns, it can be a fraught wait when you find your outsourced expert is an international flight away. And be sure he or she has the skills you outsourced in the first place.

I think a local presence, what we call in our jargon localisation, is one of the things that differentiates us, says Mr Orzeske. In a sprawling region that includes Europe and Russia, the Middle East and Africa, he has day to day responsibility that a $700 m business is running smoothly. And, if sales are anything to go by, it is.

The refining segment is going very well, he says. Sales are up by 21% compared with the previous year: “There’s been a lot of spend in the last 18-24 months, following a long period of slowness,” he says. “We’re continuing to see a strong year this year.”

So why is someone managing such an enormous region going out on a limb to stress the value of local relationships?

“A local staff is very important to our customers, and it is something we’ve worked very hard on. It dictates how we structure the business and means that we have 41 legal entities within our region alone.

“Local support does mean flying someone in from the UK. For us, it means a local person, with local culture and language who can be left onsite to support the office. Engineers in local offices, long term, is our approach.”

He points to Honeywell’s 30 years in Moscow and its offices in other then ‘iron curtain’ countries which have been in place for 25 years. “Our latest office is in Algeria, and here again we’ll seek local people.

And just as refining companies have invested knowledge in people, they’ve also invested in learning to work with existing equipment. “I suppose the other thing that differentiates us is that we’ve worked very hard so that our customers aren’t forced to migrate from technology that is working very well for them,” says Mr Orzeske. “We’ve put a lot of effort into backward compatibility.”

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